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FIRE EFFECTS ON UNDERSTOREY SHRUBS

by

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SUMMARY

Study of the impact of prescribed burning on the understorey of mixed eucalypt forest in the south-west of Western Australia revealed little change in composition. There were however, marked changes in structure as the vegetation recovered from the effects of fire. The persistent species regenerating from lignotuberous root-stock recovered most rapidly, whereas fireweeds regenerating from seed only regained their former level in cover contribution in the third year.

INTRODUCTION

This study aimed at observing some effects of spring prescribed mild burning on the regeneration of understorey scrub (major component species: *Acacia strigosa*, *A. pulchella* and *Bossiaea aquifolium*) amongst mixed eucalypt forest, 16 km west of Manjimup in the lower south-west of Western Australia.

The three most common trees in this forest are karri (*Eucalyptus diversicolor* F. Muell), jarrah (*E. marginata* Sm.) and marri (*E. calophylla* R.Br.). The forest floor supports an understorey of perennial shrubby and herbaceous plants, known locally as scrub. This scrub varies from relatively sparse plants 0.3 – 0.9 m high, up to dense thickets over 3 m high.

The thickets are mainly formed by various species of Bossiaea and Acacia. Intense fires in summer often precede a dense regeneration of these species, hence they are commonly referred to as fireweeds. Other evidence (Peet 1971) suggests mild prescribed burning in spring may not reproduce the same favourable conditions for regeneration of fireweeds. Burning dense thickets of fireweeds has resulted in a greater profusion of other species in the scrub.

The differences in the effect of summer wildfires and spring prescribed burning upon regeneration are not understood. It may be purely preparation of the seed bed, in that less trash and duff are removed by spring burns, or the effect may be through the stimulation of seed germination; perhaps it is a combination of these factors with others which make up the favourable conditions.

Regular prescribed burning in both spring and autumn is a standard fire control measure in these forests. It is thought the dense thickets of scrub may have regenerated after intense fires which have been common in the recent past. The optimum conditions for prescribed burning are in spring, when moisture levels are high and the consequent forest damage is minimal. (Peet and McCormick 1971). In summer, fires that burn in these thickets are often very intense and difficult to control.

For fire control, it is desirable to replace these thickets with smaller, less dense scrub. There were fifty six species in the study area of which only three were dense fireweeds. (See list on p. 6). The above ground portions of these species are easily killed by mild fires. Some regenerate very quickly from lignotuberous rootstock while others, including fireweeds, take longer since they grow only from seedlings.

The study area was covered with scrub which had regenerated after an intense summer fire 5 years before. Plots were established in thickets of dense fireweed. After measurement the plots were burnt and the recovery of scrub was studied over the following 3 years.

THE STUDY AREA

Manjimup has a Mediterranean climate with an average annual rainfall of 1092 mm.

The scrub species found in the study area are listed on page 6. Species were identified from Blackall (1954) and Beard (1970). The three fireweeds which formed separate, dense thickets were *Acacia strigosa* Link., A. *pulchella* R.Br. and *Bossiaea aquifolium* Benth.

Three pairs of plots were established, one pair in each of the fireweed thickets. The original scrub structure of these plots is shown in Figure 1. Each pair was comparable in height and density. One plot was subsequently burnt and the other kept as an unburnt control.

Tree sizes in the plots ranged from saplings to mature trees over 2.0 m girth. The forest is described in Table 1.

TABLE 1

Forest Type

	Fireweed		
	A. strigosa	A. pulchella	B. aquifolium
Control Plots –			
(a) Canopy Cover %	64	64	66
Tree Type	Pole and pile-sized jarrah and marri	Pole and pile-sized marri and karri	Saplings and mature karri
Burnt Plots –			
(a) Canopy Cover %	67	66	83
Tree Type	Sapling and pole-sized jarrah and marri; one large karri	Pole and pile-sized marri and karri	Saplings and mature karri

EXPERIMENTAL METHOD

Each plot was 40 m x 40 m. A perimeter buffer was left and measurements were made only in the central 18 m x 18 m square. Two methods were employed for measuring scrub; a point sampling technique developed by Levy and Madden (1933) and an area quadrat technique of counting plants contained within 0.6 m squares.

Point Quadrat Method

Hopkins (1964) described the method for using point sampling technique to measure scrub cover:

> The method consists of passing a pin or narrow rod vertically down through the vegetation. The number of rod contacts with plant species parts is recorded each time the rod is dropped. Theoretically the recorded contacts are those vertically above a dimensionless point on the ground. Slight errors result in practice both from the finite diameter of the rod and variable observer interpretation of the nature of the contact.

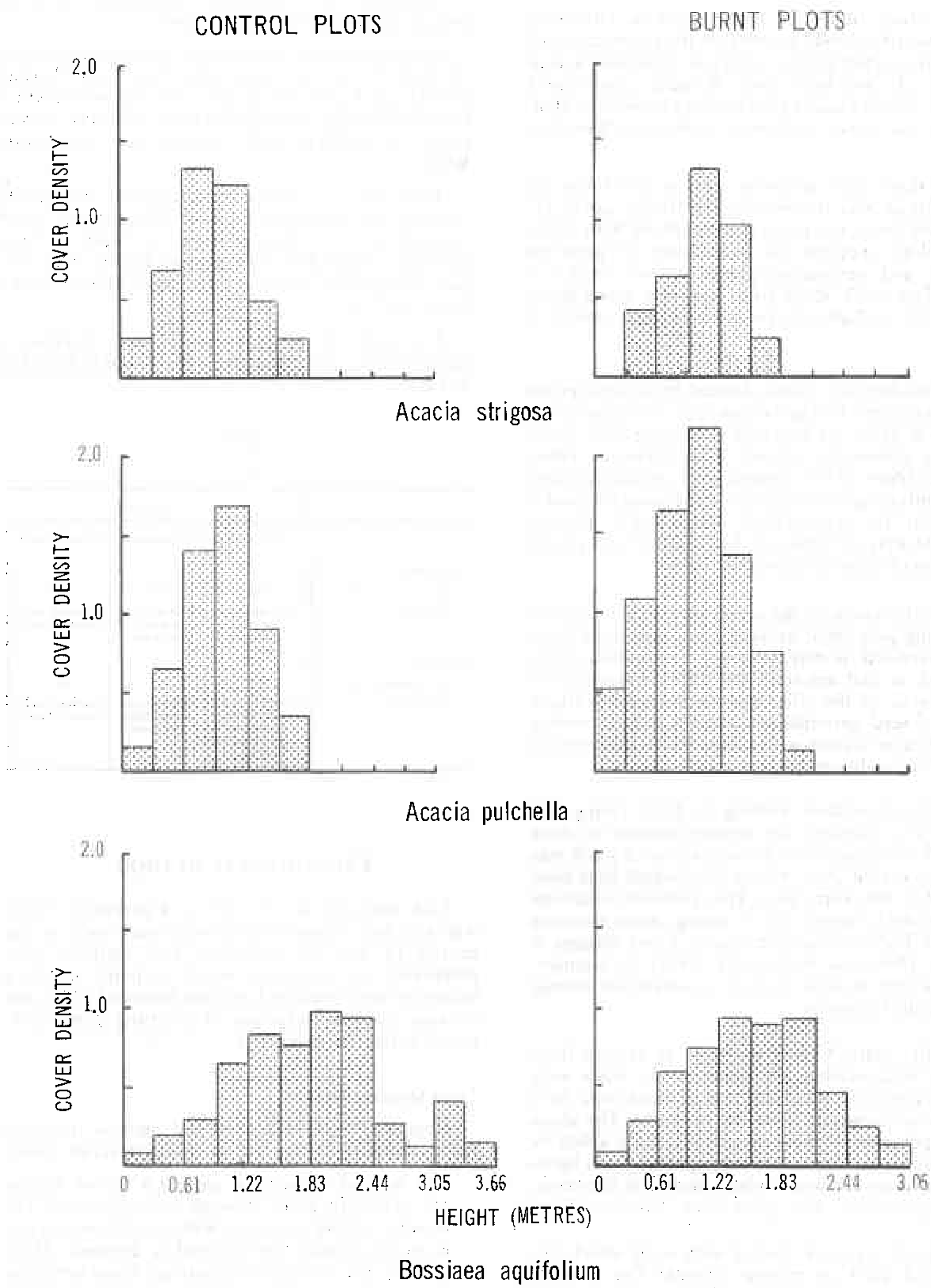

FIGURE 1: *Scrub structure of plots before burning.*

Scrub species were described by three expressions: percentage frequency, relative cover contribution and cover density.

(1) Percentage frequency for each species

$$= \frac{\text{Number of rods with one or more contacts for the species} \times 100}{\text{Total number of rod positions}}$$

(2) Relative cover contribution for each species

$$= \frac{\text{Total number of contacts recorded for a species} \times 100}{\text{Total number of contacts for all species}}$$

(3) Cover density for each species

$$= \frac{\text{Total number of contacts for a species}}{\text{Number of rods with at least one contact for the species}}$$

A stratified random sampling technique ensured that the sampling covered the whole plot area. The central measured plot was divided into thirty-six 3 m x 3 m squares. Points were randomly located in each square.

The sampling intensity was worked out by plotting 100 points against percentage frequency or cover density, then adding more points distributed through all the sub-plots until a fairly constant value was obtained (Hopkins 1964). It was decided 360 points were sufficient for reliable sampling.

Point sampling was used to show changes in the structure of scrub during the 3 years after burning.

Area Quadrats

Area quadrats were measured in the burnt plots to provide measurements of numerical changes in scrub species. This was necessary in the first year or two after the fires when plants were still very small and difficult to detect with the point method.

Plants were counted in each of the 25 randomly located 0.6 m square quadrat plots. The percentage frequency, relative cover contribution and cover density were worked out with these formulae:

(1) Percentage frequency for each species

$$= \frac{\text{Number of quadrats including a species} \times 100}{\text{Total number of quadrats}}$$

(2) Relative cover contribution for each species

$$= \frac{\text{Total number of plants for a species} \times 100}{\text{Total plants for all species}}$$

(3) Cover density for each species

$$= \frac{\text{Total number of plants for a species}}{\text{Number of quadrats in which found}}$$

Prescribed Burning

Each plot was burnt by a spot fire lit at its centre. Fire intensity and fuel and weather variables were measured with the technique described by Peet (1965). Fire intensity was expressed with Byram's (1959) formula:

$$I = Hwr$$

Where I = Fire intensity in kilowatts per metre,
H = Heat yield,
w = Available fuel weight,
r = Rate of fire spread

Heat yield of the fuel was estimated at 18,600 kJ/kg. A record of fire behaviour during the fires is given in Table 2.

TABLE 2

Fire Behaviour

Species	Headfire Flame Height (m)	Headfire Rate of Spread (m/min)	Fire Intensity (kilowatts/metre)
A. strigosa	0.24	0.33	90.0
A. pulchella	0.21	0.36	65.7
B. aquifolium	0.4	0.40	55.4

Fire intensity was mild ranging from 55 to 90 Kw/m. The flames were about 0.3 m high and burned quietly under the tall fireweeds. The burning was done in spring when the duff and soil were still damp after winter rains.

All the above-ground portions of scrub in the plots were killed by these fires.

EXPERIMENTAL RESULTS

Fireweeds

The burnt plots were measured before burning and then each year afterwards. The control plots were likewise measured before burning but only once afterwards, 3 years later (Figures 2a, b, c).

The changes induced by burning were reflected somewhat differently in quadrat and point sampling respectively. The general trend was marked drop in all three parameters (frequency, cover contribution and cover density) in the first two years after the burn, followed by partial recovery in the third year. The detection of changes by the two sampling techniques diverged most in the case of *Acacia strigosa*, in that the third year recovery was detected by point sampling, but not by quadrat sampling. Point sampling is more strongly influenced by vertical structure of the vegetation.

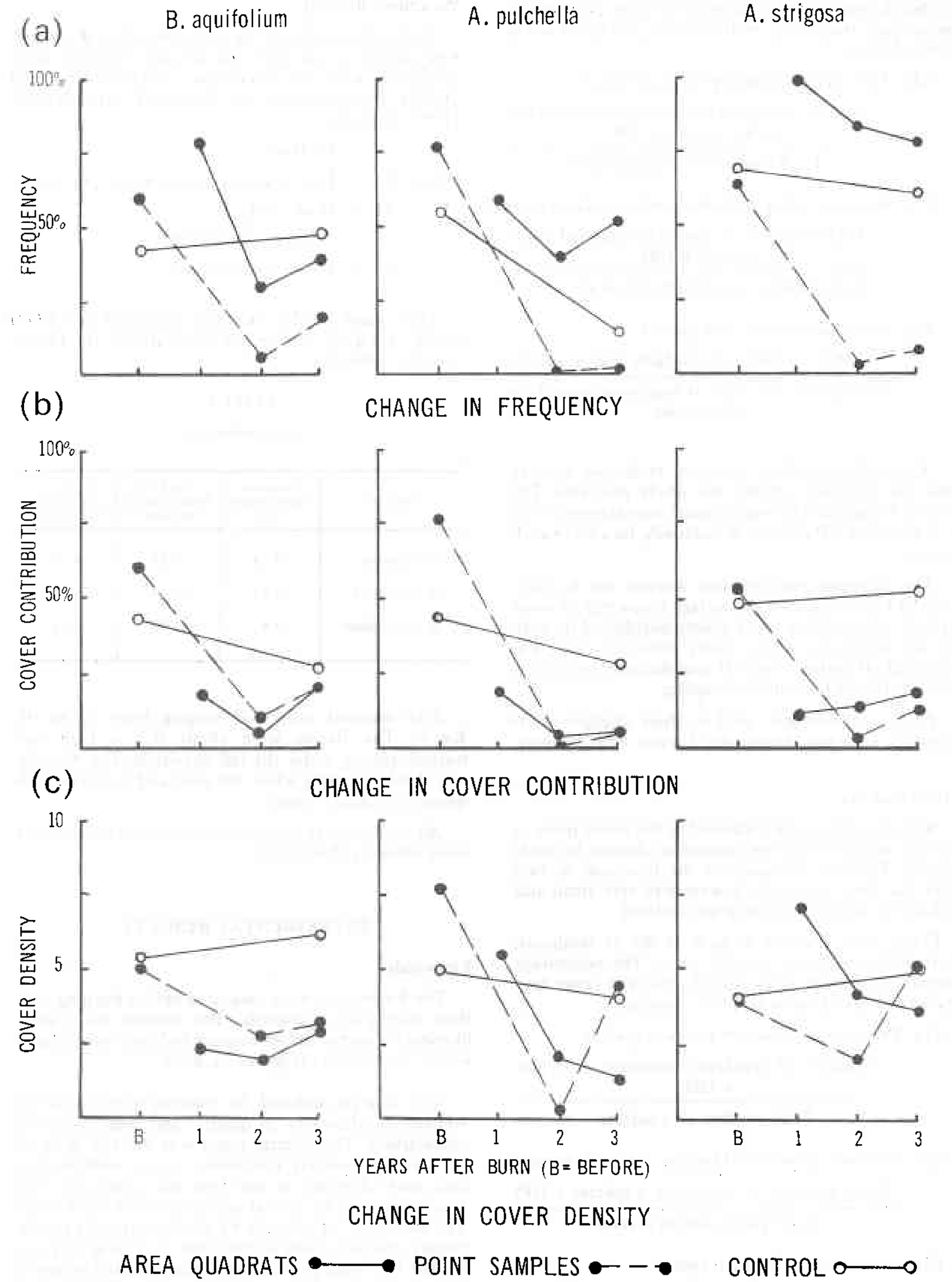

FIGURE 2: *Change in percentage frequency, cover contribution and cover density for three fireweeds after burning.*

The quadrat method gave much high percentage frequencies for the fireweeds after burning. The two methods gave more comparable results for cover contribution and, to a lesser extent, for cover density. Relative cover contribution did not appear to recover as well as either frequency or cover density.

Other Species

The decline of fireweed dominance after burning was accompanied by an increase of other species. This change is illustrated by Figure 3, which shows numbers of species with a frequency greater than 0.3 percent before and after burning. Similar results are produced if cover contribution greater than 0.1 percent or cover density greater than 1.0 is used instead. The highest increase in numbers took place in the burnt *A. strigosa* plot.

An increase in numbers of species was also evident in the control plots.

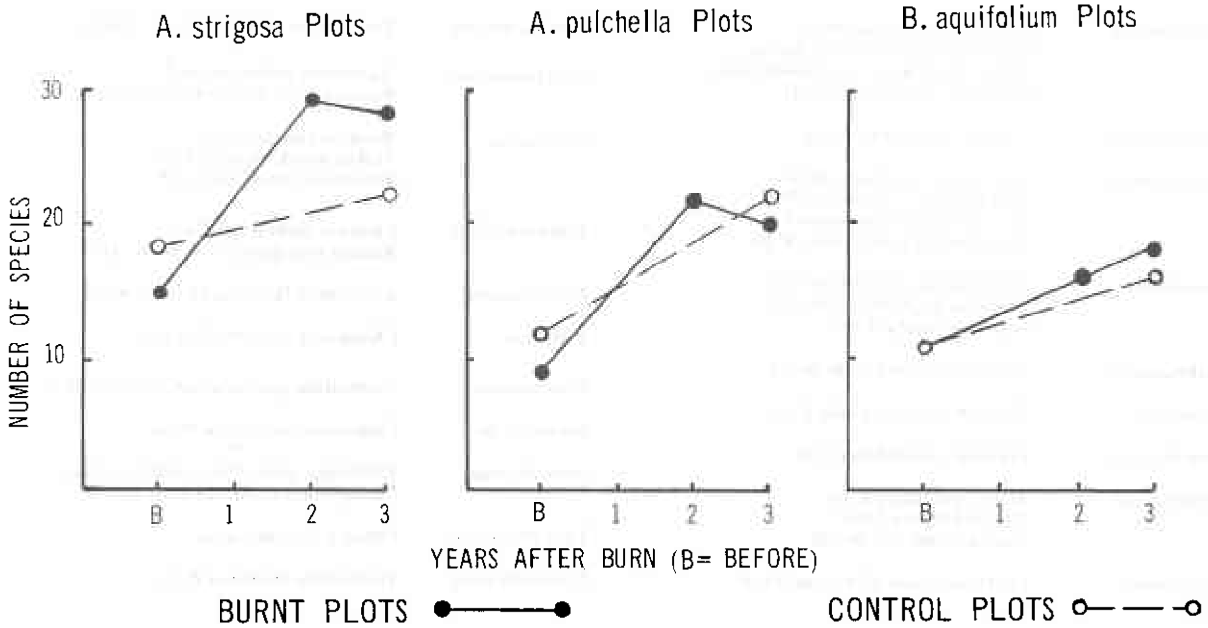

FIGURE 3: *Change in the number of species with percentage frequency greater than 0.3.*

DISCUSSION

Large differences in the size of plants before and after the fires made it difficult to decide how the fireweeds would recover if they continued to be protected from further burning. Measurements will be taken over the next 2 years to give them the opportunity of reaching the same size as they were before burning. These species which regenerate from seed did not develop as fast as those which regenerated from a lignotuberous rootstock.

Using these definitions of frequency, plant size undoubtedly contributed to the different percentage obtained by point sampling and area quadrats. Point sampling showed dramatic decreases, yet 40 percent or more of the quadrats held at least one fireweed plant in the third year after burning. These plants may grow sufficiently in size in the next 2 years to regain their former dominance.

Although increases in species numbers were observed in all, some species could well have been present at the time of first assessment, but below the specified frequency level on 0.3 percent. The increase in number of species is most likely to be real rather than apparent in case of plot dominated by *Acacia strigosa*. The fire in this plot reached the highest intensity, and the removal of litter was most thorough. The increase in number of species with frequency exceeding 0.3 percent is largely due to species regenerating from rootstocks. The relative contribution of species known to regenerate by seed, fell from 53 percent of all rod contacts before burning to 13 percent three years after burning. The changes were far less clear cut in plots dominated by *Bossiaea aquifolium* and *Acacia pulchella*, where similar increases occurred in both burnt and unburnt plots. There is no evidence these mild prescribed fires caused a species to disappear. However, scrub in forest recently burnt by prescribed fires may well be dominated by species regenerating from rootstock for at least 3 years.

SPECIES RECORDED ON THE PLOTS

Family	Species	Family	Species
Apiaceae	Platysace tenuissima (Benth.) Norman Trachymene glaucifolia (F. Muell.) Benth. Xanthosia huegelii (Benth.) Steud.	Papilionaceae	Bossiaea aquifolium Benth. Bossiaea linophylla R.Br. Hovea chorizemifolia (Sweet.)D.C. Hovea elliptica (Sm.) D.C. Kennedia coccinea Vent. Sphaerolobium medium R.Br.
Casuarinaceae	Casuarina decussata (Benth.)		
Caryophyllaceae	Stellaria multiflora		
Compositae	Helichrysum ramosum D.C.		
Cycadaceae	Macrozamia reidlei (Gaud.) C.A. Gard.	Pittosporaceae	Billardiera varifolia Turez
Dilleniaceae	Hibbertia montana Steud. Hibbertia amplexicaulis Steud. Hibbertia cuneiformis (labill.) Gilg. Hibbertia inconspicua Ostf.	Podocarpaceae	Podocarpus drouynianus F. Muell.
		Polypodiaceae	Adiantum aethiopicum L. Pteridium esculentum (Forst.f.)
Droseraceae	Drosera macrantha Endl.	Proteaceae	Banksia grandis Willd. Hakea amplexicaulis R.Br. Persoonia longifolia R.Br.
Epacridaceae	Leucopogon australis R.Br. Leucopogon capitellatus D.C. Leucopogon propinquus R.Br. Leucopogon verticillatus R.Br.	Ranunculaceae	Clematis pubescens Hueg. Ranunculus pumilio R.Br. ex D.C.
Goodeniaceae	Scaevola macrophylla Benth. Scaevola microphylla Benth. Scaevola striata R.Br.	Restionaceae	Loxocarya flexuosa (R.Br.) Benth
		Rutaceae	Chorilaena quercifolia Endl.
Haloragaceae	Haloragis rotundifolia Benth.	Rhamnaceae	Trymalium spathulatum (Labill.) Ostf.
Iridaceae	Patersonia occidentalis R.Br.	Sapindaceae	Dodonaea caespitosa Diels.
Loganiaceae	Logania serpyllifolia R.Br.	Sterculiaceae	Thomasia quercifolia (Andr.) J. Gay Lasiopetalum floribundum Benth.
Mimosaceae	Acacia pulchella R.Br. Acacia strigosa Link. Acacia urophylla Benth.	Thymelacaceae	Pimelea clavata Labill.
Myrtaceae	Leptospermum ellipticum Endl.	Tremandraceae	Tremandra stelligera R.Br.

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